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RESEARCH MEMORANDUM

for the

Bureau of Aeronautics, Navy Department

AN INVESTIGATION OF THE AERODYNAMIC CHARACTERISTICS OF AN
 0.08-SCALE MODEL OF THE CHANCE VUGHT XF7U-1 AIRPLANE
 IN THE LANGLEY HIGH-SPEED 7- BY 10-FOOT TUNNEL
 PART IV - AILERON CHARACTERISTICS
 TED NO. NACA DE308

By

Kenneth W. Goodson and Boyd C. Myers, II

Langley Memorial Aeronautical Laboratory
 Langley Field, Va.

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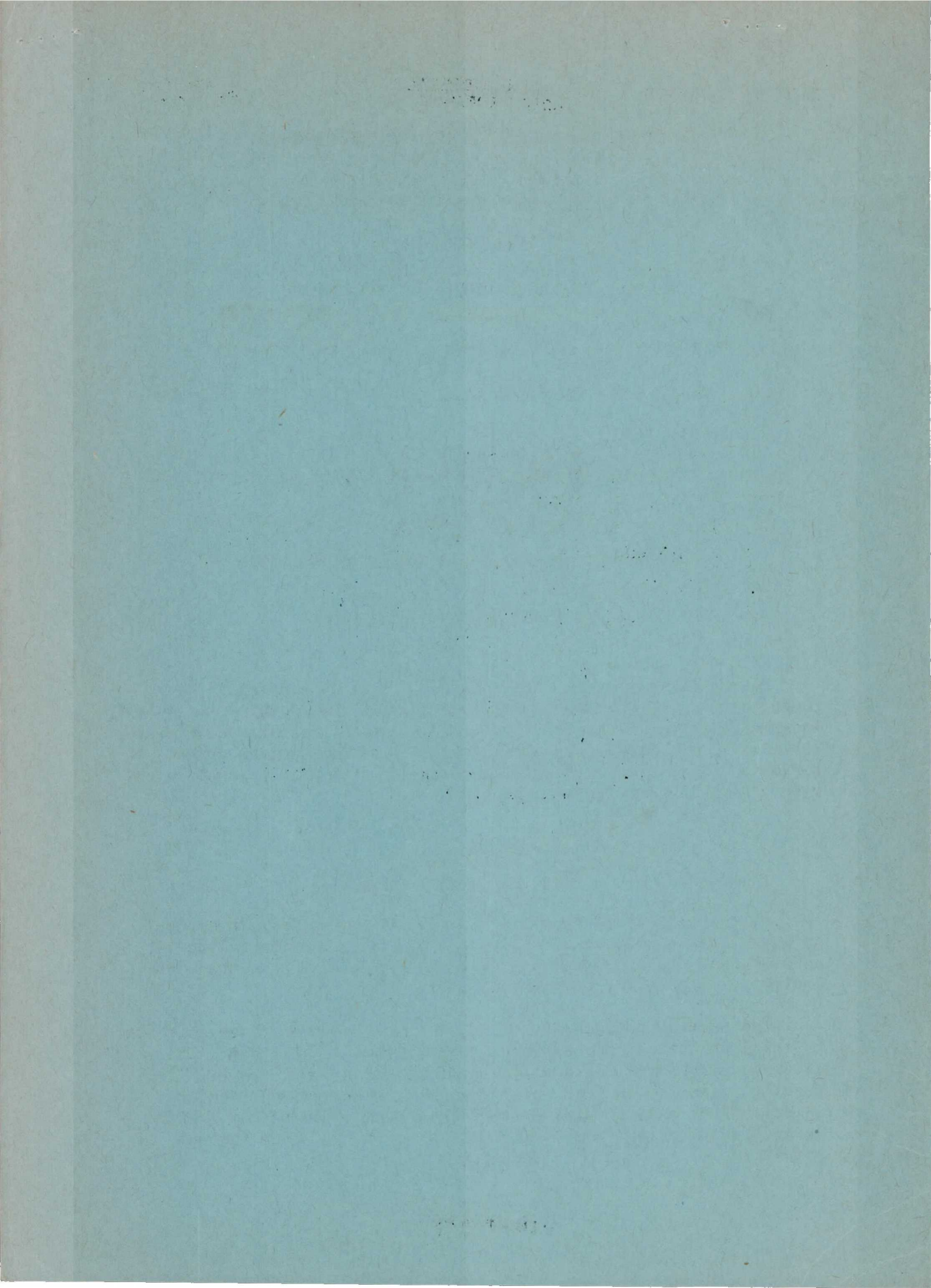
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SUMMARY

Tests have been conducted in the Langley high-speed 7- by 10-foot tunnel over a Mach number range from 0.40 to 0.91 to determine the stability and control characteristics of an 0.08-scale model of the Chance Vought XF7U-1 airplane. The aileron characteristics of the complete model are presented in the present report with a very limited analysis of the results.

INTRODUCTION

At the request of the Bureau of Aeronautics, Navy Department, an investigation of the stability and control characteristics of an 0.08-scale model of the Chance Vought XF7U-1 airplane was conducted in the Langley high-speed 7- by 10-foot tunnel.

The control surfaces of this model are referred to as ailevators by the manufacturer and are used as elevators or ailerons. The aileron characteristics are presented in the present paper. The results presented include rolling-moment, yawing-moment, and lateral-force data for the complete model for aileron (ailevator) deflections varying from approximately 4° to -19° over an angle of attack range for Mach numbers ranging from 0.40 to 0.91.

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The present paper is published with the purpose of presenting the data immediately available from high-speed tests of an 0.08-scale model of the XF7U-1 airplane. Accordingly, no detailed analysis of the data has been made.

The basic longitudinal stability characteristics and the basic lateral stability characteristics are presented in references 1 and 2, respectively. The longitudinal control characteristics are presented in reference 3.

COEFFICIENTS AND SYMBOLS

The system of axes used for the presentation of the data together with an indication of the sense of the positive forces, moments, and displacements is presented in figure 1. Pertinent symbols are defined as follows:

C_L lift coefficient $\left(\frac{\text{Lift}}{qS} \right)$

C_D drag coefficient $\left(\frac{\text{Drag}}{qS} \right)$

C_Y lateral-force coefficient $\left(\frac{Y}{qS} \right)$

C_N yawing-moment coefficient $\left(\frac{N}{qSb} \right)$

C_L rolling-moment coefficient $\left(\frac{L}{qSb} \right)$

Y lateral force measured along Y-axis

L rolling moment about X-axis

N yawing moment about Z-axis

q free-stream dynamic pressure, pounds per square foot $\left(\frac{\rho V^2}{2} \right)$

S wing area (3.174 sq ft on model).

c' wing mean geometric chord (M.G.C.) (1.046 ft on model)

c chord, parallel to plane of symmetry

c_l	chord, perpendicular to 0.25c line
b	wing span (3.093 ft on model)
V	air velocity, feet per second
a	speed of sound, feet per second
M	Mach number $\left(\frac{V}{a}\right)$
R	Reynolds number $\left(\frac{\rho V c}{\mu}\right)$
μ	absolute viscosity, pound-seconds per square foot
ρ	mass density of air, slugs per cubic foot
α	angle of attack, measured from the X-axis to the fuselage center line, degrees
α_{static}	angle of attack under no load conditions
ψ	angle of yaw, degrees
δ	control-surface deflection with reference to wing chord line parallel to the plane of symmetry, degrees
Subscripts:	
a_l	left ailevator
a_r	right ailevator

APPARATUS AND METHODS

Model

The 0.08-scale steel model of the XF7U-1 airplane used in this investigation was constructed by the Chance Vought Aircraft Division of the United Aircraft Corporation. Pertinent dimensions of the model are presented in figure 2. The control surfaces (ailevators) were constant chord with sealed gaps.

Tests

The model was tested through the Mach number range at various angles of attack for several aileron (ailevator) deflections. To determine the aileron characteristics, the model was tested with the left ailevator deflected while holding the right ailevator in a neutral position. The model was tested on a sting support as shown in figure 3. In order to evaluate tares, the model was also tested on wing tip stings (fig. 4) with and without the center sting. A more complete description of the testing technique employed is given in reference 1.

The variation of test Reynolds number with Mach number for average test conditions is presented in figure 5. The size of the model used in the present investigation resulted in an effective tunnel choking Mach number of about 0.94. Experience has indicated that with this value of choking Mach number the data should be reliable up to effective Mach numbers of about 0.91.

CORRECTIONS

The test results have been corrected for the tare forces and moments produced by the support system except for a small constant rolling-moment coefficient which was found to be caused by extraneous forces on the balance system but which was not accounted for in the tare determination. The rolling-moment coefficients in this report can be corrected by subtracting the value 0.0008 from the rolling-moment coefficients presented. This small correction should also be applied to the rolling-moment coefficients presented in reference 2.

The jet-boundary corrections were computed from the following equations which were determined by the method in reference 4.

$$\alpha = \alpha_M + 0.331C_{LM}$$

$$C_D = C_{DM} + 0.0058C_{LM}^2$$

where the subscript M indicates the measured value.

All coefficients and Mach numbers were corrected for blocking by the model and its wake.

RESULTS AND DISCUSSION

Most of the test results presented are for the complete model configuration consisting of the wing, fuselage, canopy, and vertical tails. (See fig. 3.) Several tests were made with the vertical tails removed. (See fig. 4.)

The effect of aileron (ailevators used as ailerons) deflection on the lateral characteristics through the angle-of-attack range for various Mach numbers is shown in figure 6. These data were corrected for the change of angle of attack caused by deflection of the support system when aerodynamic load was applied to the model. The drag characteristics through the angle-of-attack range for several Mach numbers are shown in figure 7. A plot of lift coefficient against angle of attack for zero ailevator deflection and for constant Mach numbers is presented in figure 8. The data of figure 6 were cross plotted at constant angles of attack to obtain the variation of lateral characteristics with Mach number for the various aileron deflections. (See fig. 9.)

Data for the tail-off configuration at a static angle of attack of about 2° are presented in figure 10. These data are uncorrected for the small changes in angle of attack of the model caused by deflection of the sting support system. The data, however, can be compared with that of figure 9 inasmuch as the lateral characteristics are not particularly sensitive to angle of attack in this range.

It is of interest to note that at low angles of attack there is an appreciable favorable yawing moment accompanying the large negative aileron deflections at all Mach numbers and that this yawing moment decreases with increase of angle of attack. A study of figure 10 indicates that this favorable yawing moment is attributable to the side force on the vertical fins induced by the deflected aileron (ailevator). The decrease in yawing moment with increase in angle of attack is probably caused by

the variation with angle of attack of the incremental-drag coefficient produced by the ailevator. (See fig. 7.)

Langley Memorial Aeronautical Laboratory
National Advisory Committee for Aeronautics
Langley Field, Va.

Kenneth W. Goodson
Kenneth W. Goodson
Aeronautical Engineer

Boyd C. Myers, II
Boyd C. Myers, II
Aeronautical Engineer

Approved:

Thomas A. Harris
Thomas A. Harris
Chief of Stability Research Division

CGB

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1. Kemp, William B., Jr., Kuhn, Richard E., and Goodson, Kenneth W.:
An Investigation of the Aerodynamic Characteristics of an
0.08-Scale Model of the Chance Vought XF7U-1 Airplane in
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Charts for Determining Jet-Boundary Corrections for Complete
Models in 7- by 10-Foot Closed Rectangular Wind Tunnels.
NACA ARR No. L5G31, 1945.

FIGURE LEGENDS

Figure 1.- System of axes and control-surface deflections. Positive values of forces, moments, and angles are indicated by arrows.

Figure 2.- General arrangement of 0.08-scale model of Chance-Vought XF7U-1 airplane.

Figure 3.- Photograph of the 0.08-scale model of the XF7U-1 airplane mounted on the center sting at a positive angle of attack.

Figure 4.- Photograph of the 0.08-scale model of the XF7U-1 airplane with vertical tails removed mounted on the wing supports with center sting in place.

Figure 5.- Variation of test Reynolds number with Mach number for 0.08-scale XF7U-1 in the high-speed 7- by 10-foot tunnel.

Figure 6.- Effect of aileron deflection through an angle-of-attack range on the lateral characteristics of the 0.08-scale model of the Chance Vought XF7U-1 airplane, $\delta_{ar} = 0^\circ$.

(a) $M = 0.40$.

Figure 6.- Continued.

(b) $M = 0.60$.

Figure 6.- Continued.

(c) $M = 0.70$.

Figure 6.- Continued.

(d) $M = 0.80$.

Figure 6.- Continued.

(e) $M = 0.85$.

Figure 6.- Continued.

(f) $M = 0.875$.

Figure 6.- Continued.

(g) $M = 0.90$.

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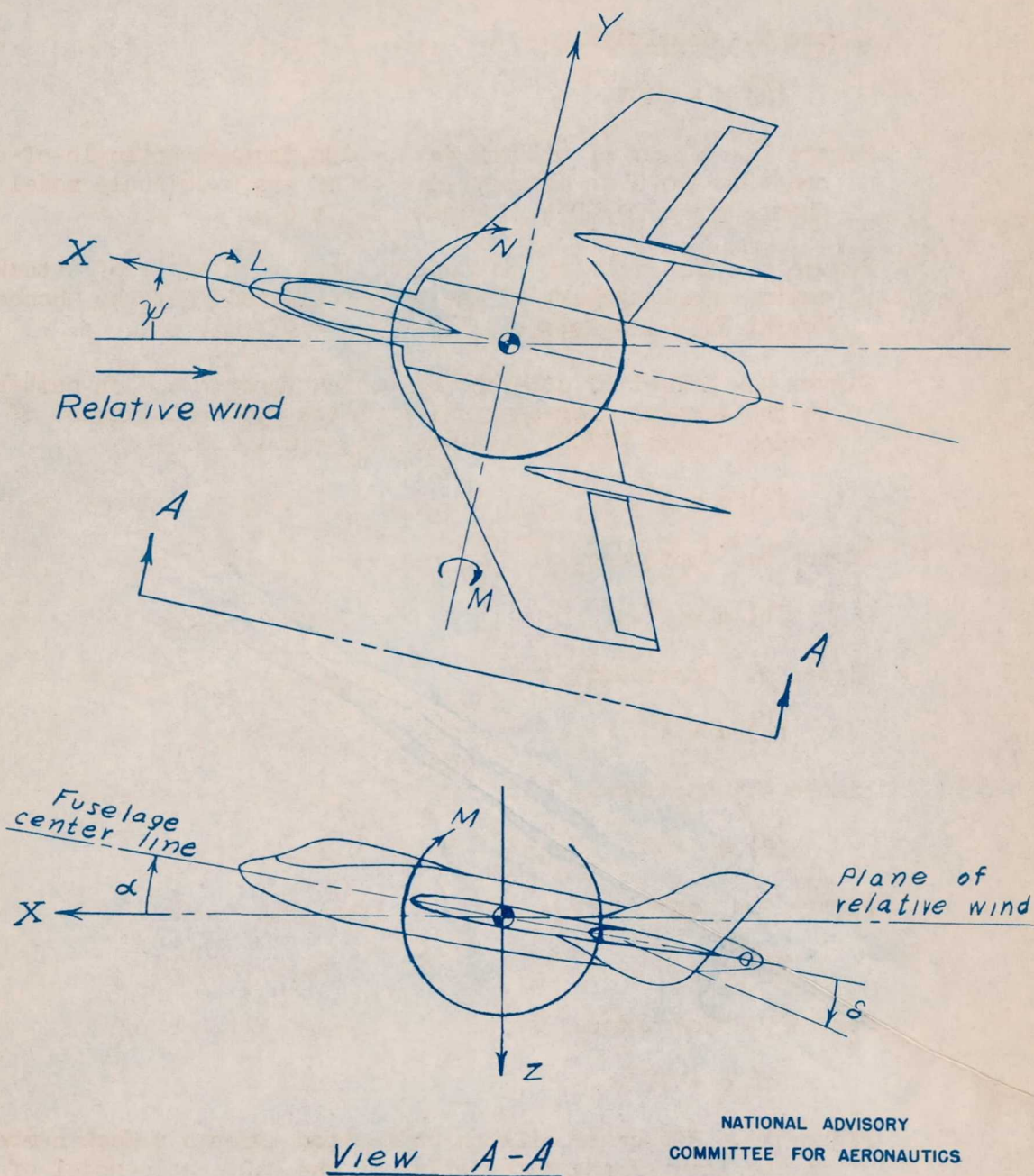
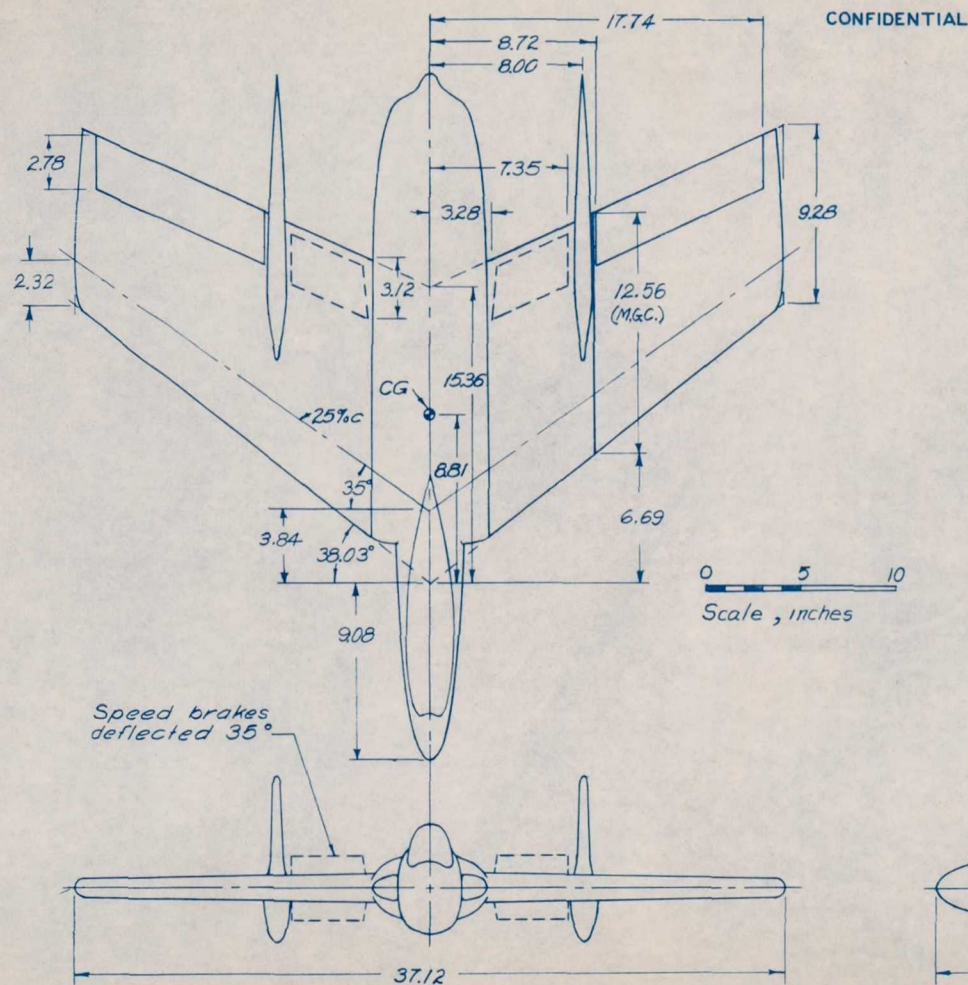


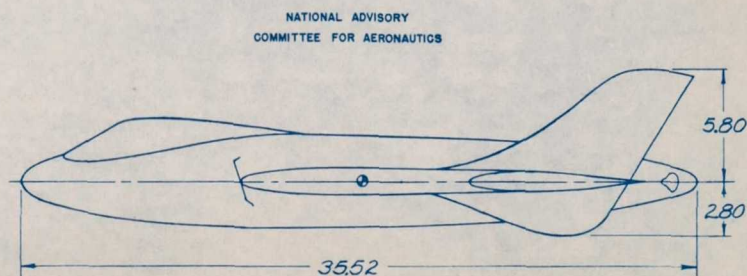
Figure 1.- System of axes and control-surface deflections. Positive values of forces, moments, and angles are indicated by arrows.

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TABULATED DATA

Wing:	
Area	3.174 sq ft
Aspect ratio	3.014
Mean geometric chord	1.046 ft
Incidence	0°
Dihedral	0°
Airfoil (perpendicular to 0.25c)	Symmetrical
Max. thickness	0.12c
Location of max. thickness	0.40c
Vertical tail	
Area (two)	0.82 sq ft
Aspect ratio	1.75
CG location	0.17 M.G.C.



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Figure 2.- General arrangement of 0.08-scale model of Chance-Vought XF7U-1 airplane.

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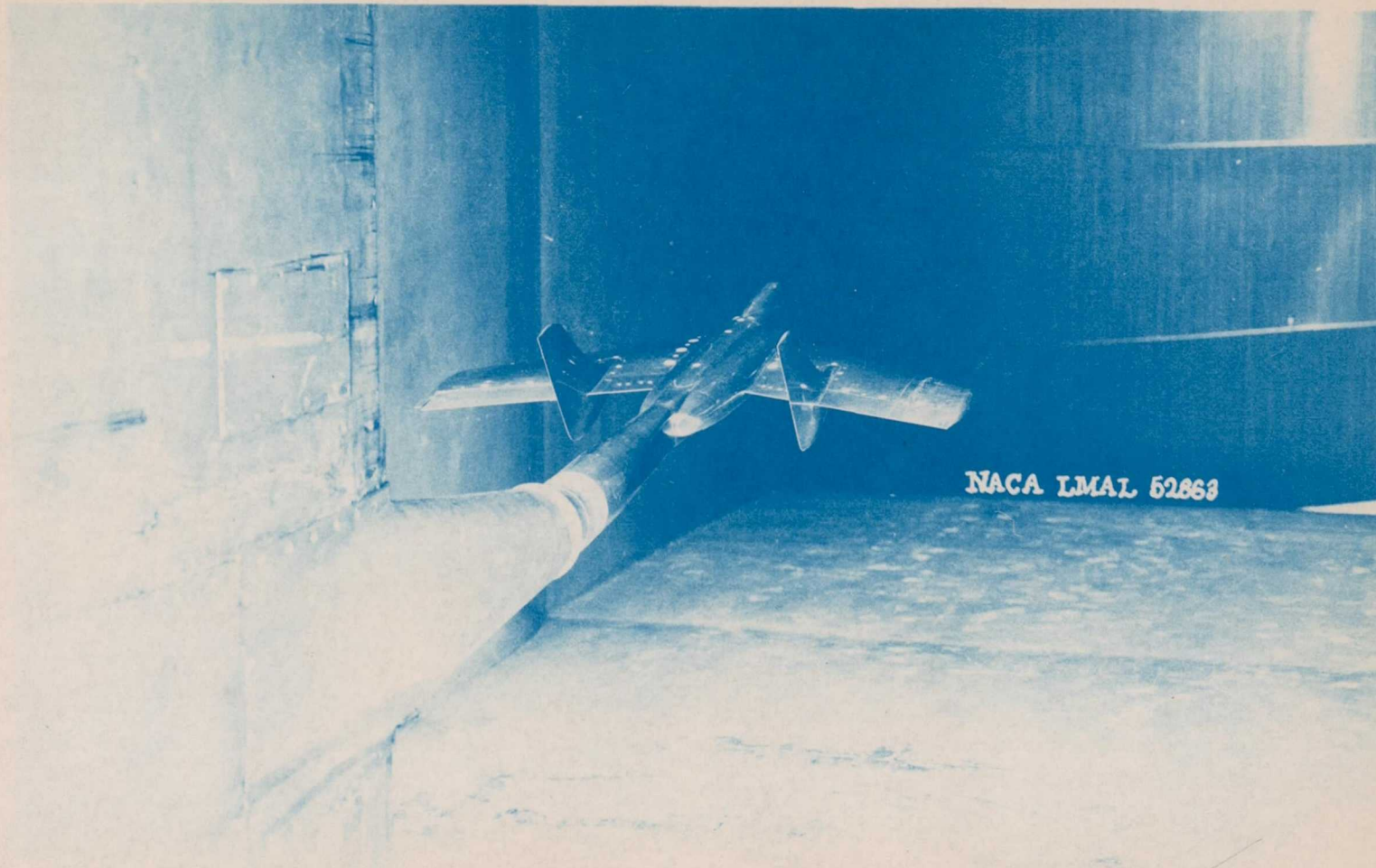


Figure 3.- Photograph of the 0.08-scale model of the XF7U-1 airplane mounted on the center sting at a positive angle of attack.

Fig. 3

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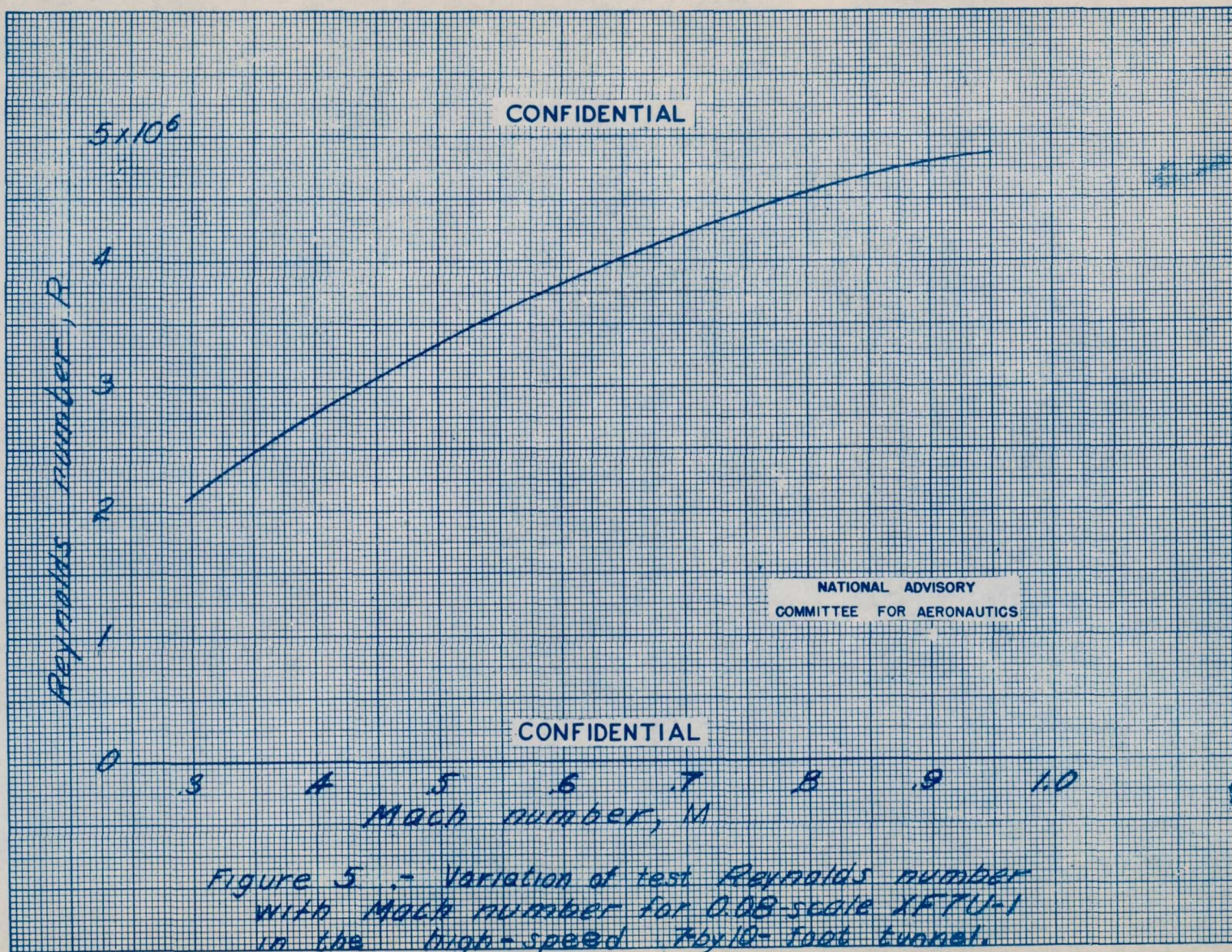


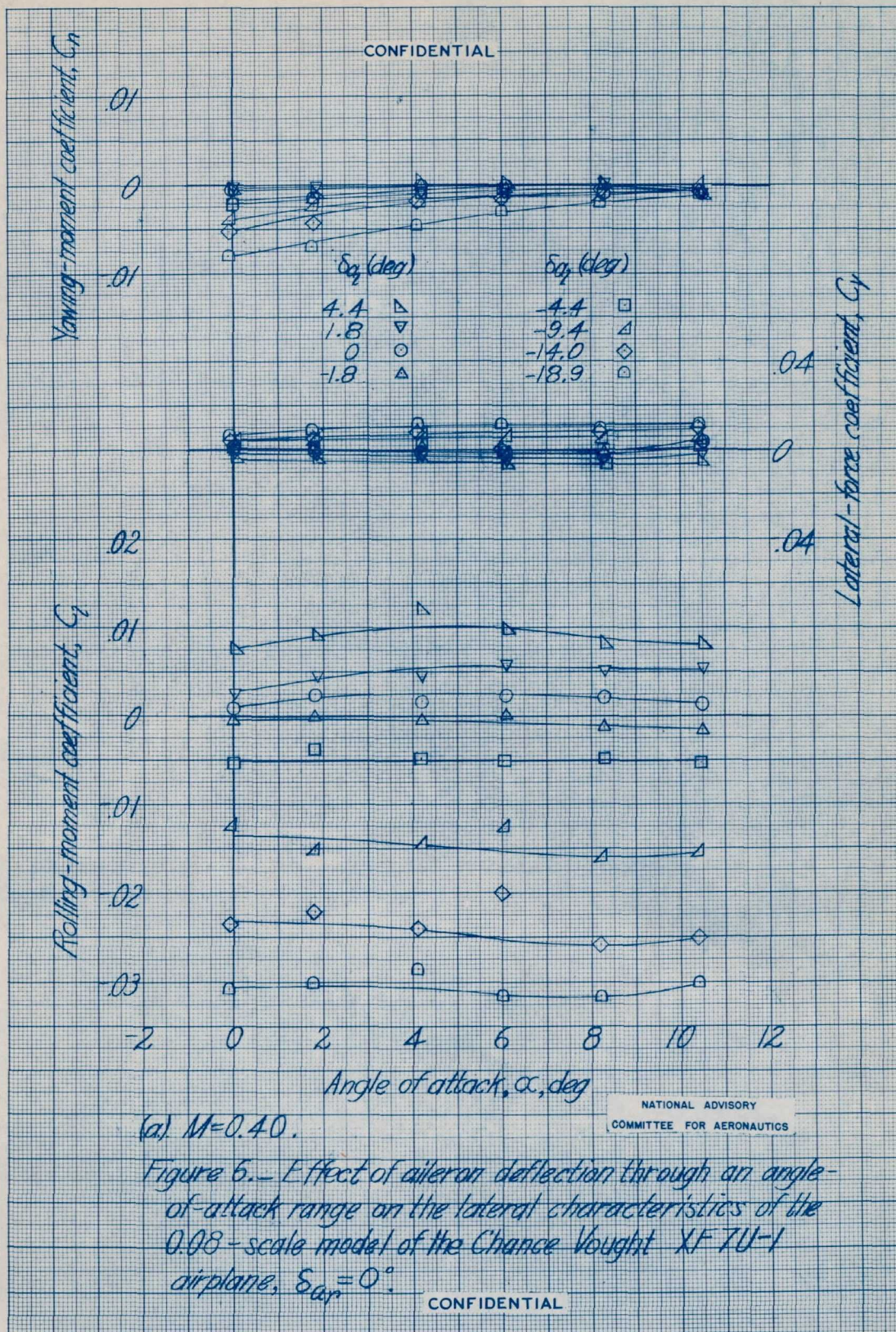
Figure 4.- Photograph of the 0.08-scale model of the XF7U-1 airplane with vertical tails removed mounted on the wing supports with center sting in place.

Fig. 4

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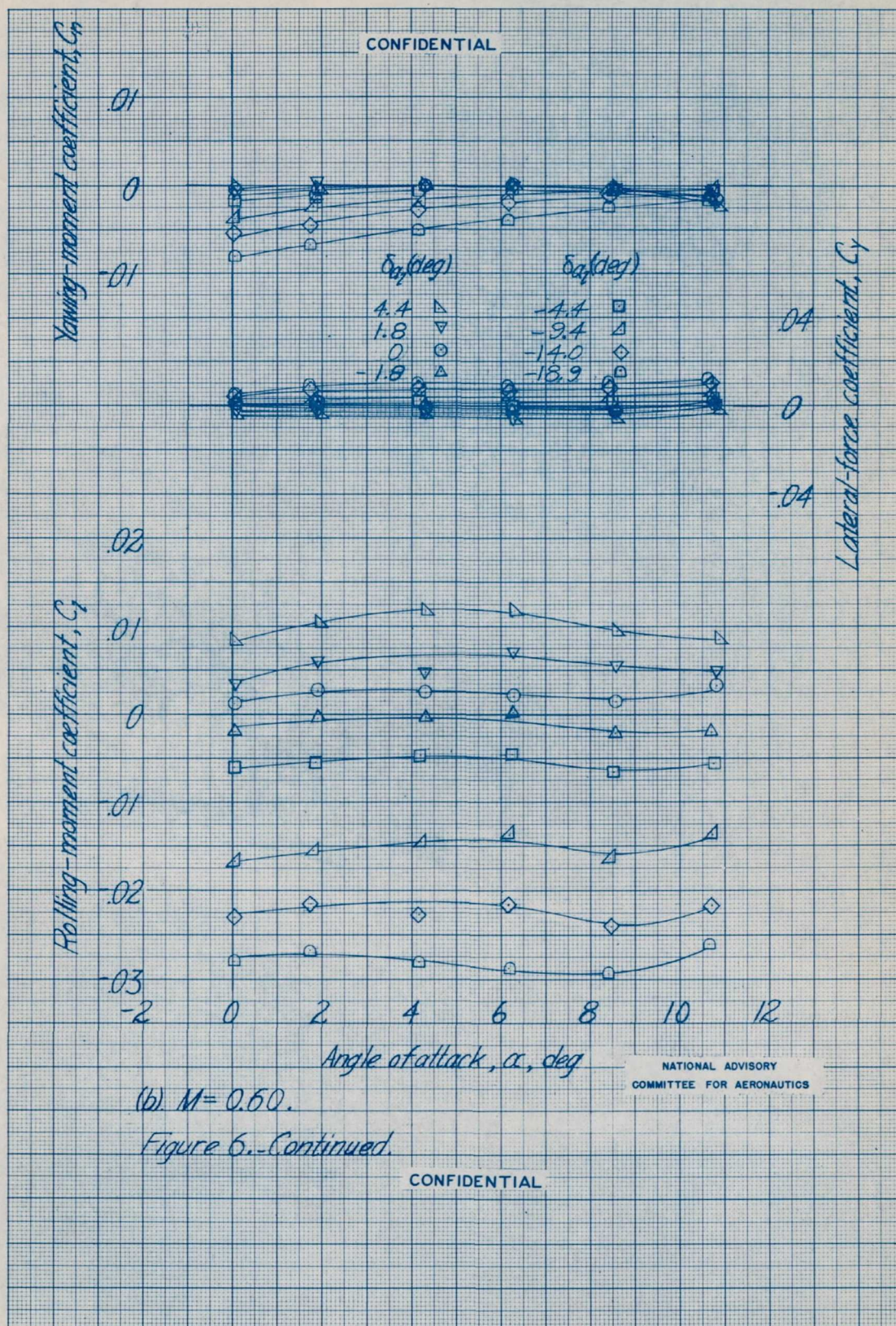
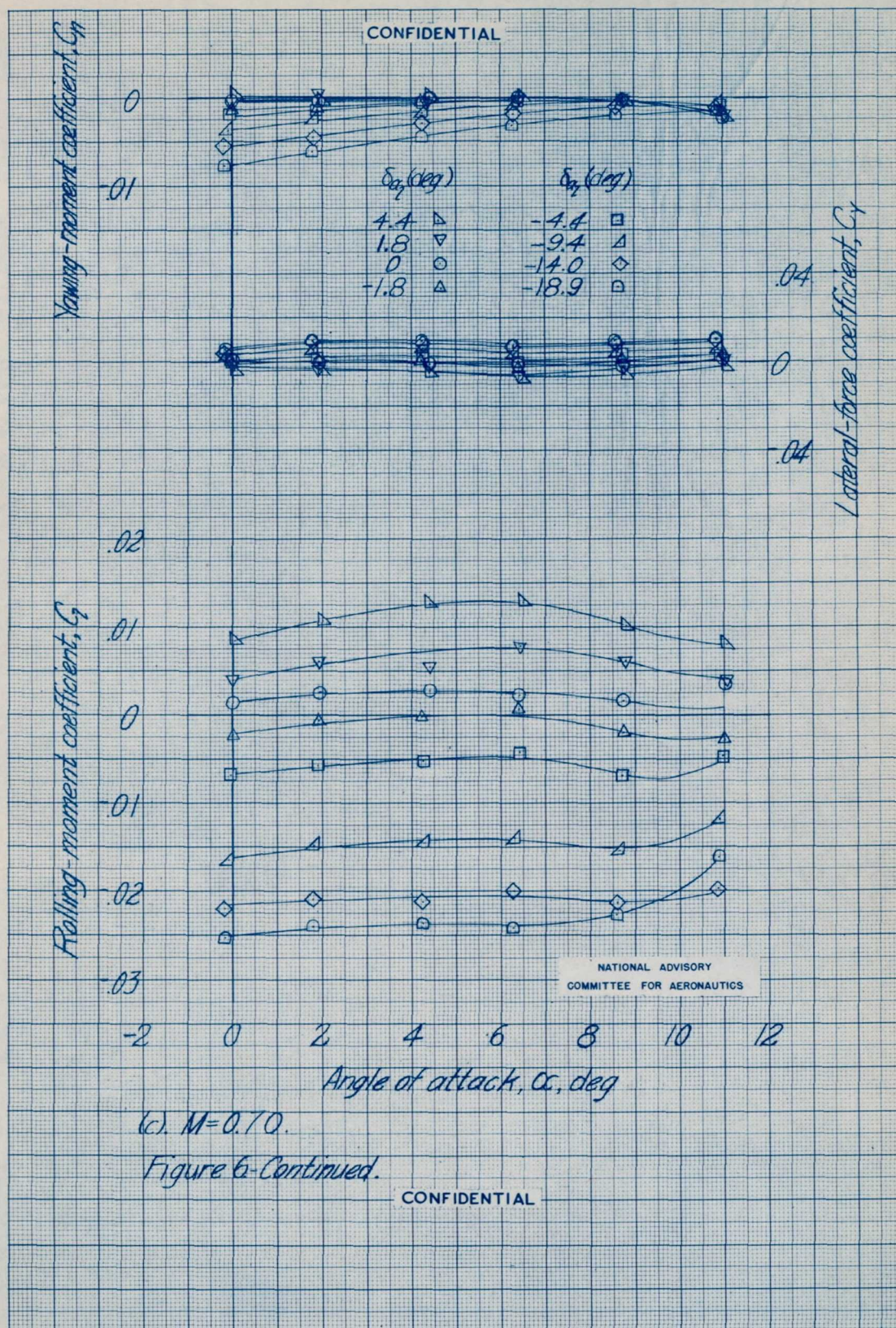
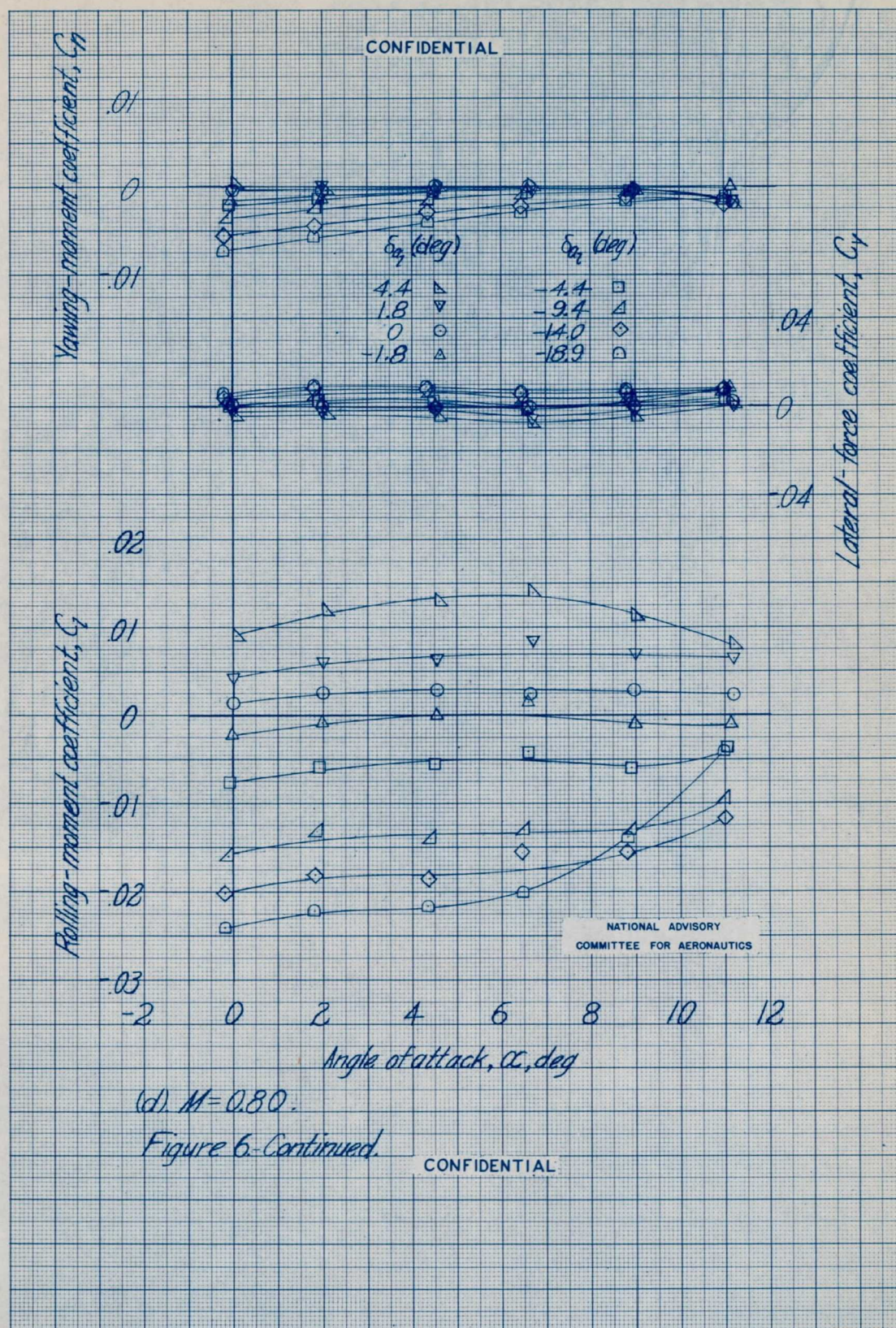
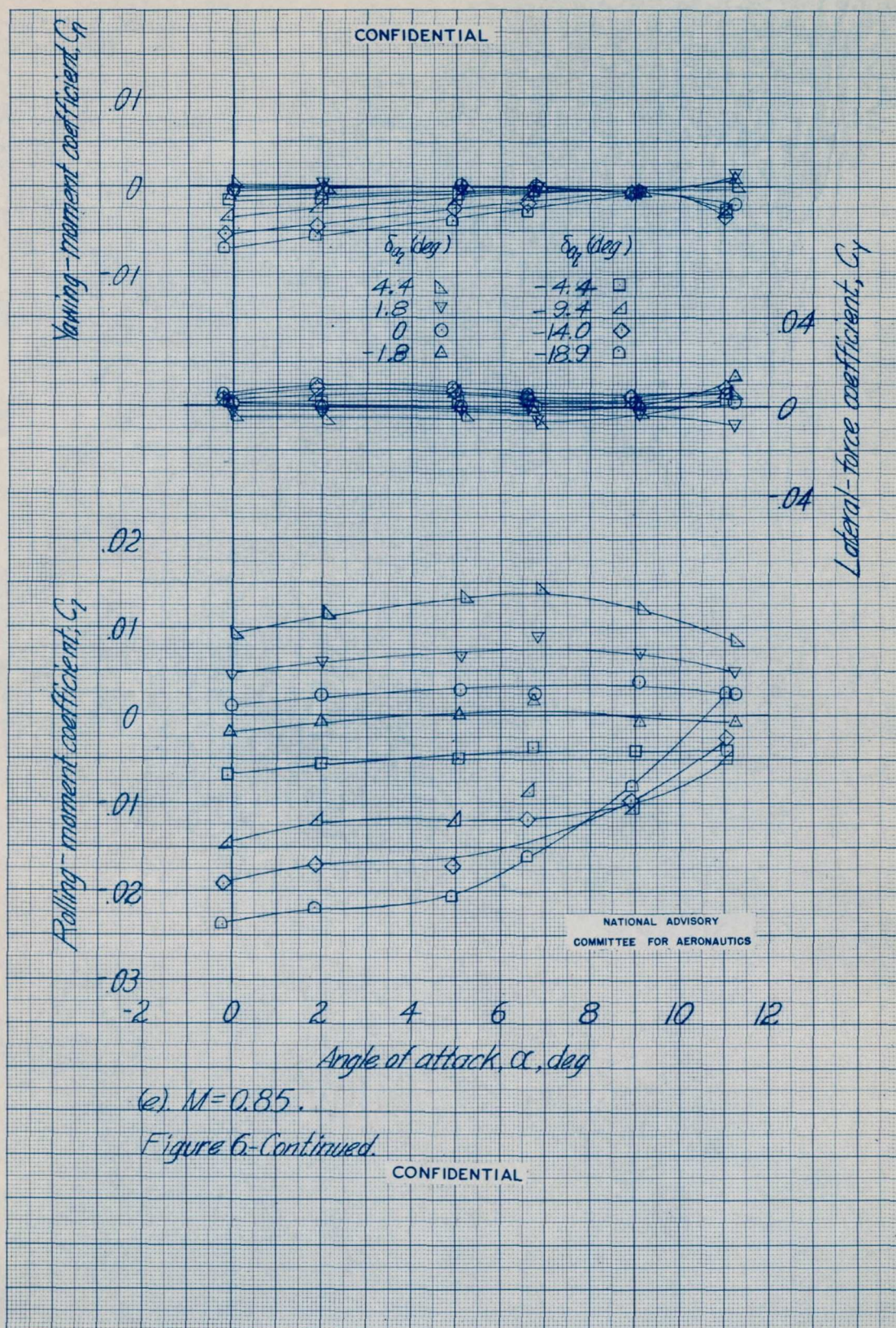
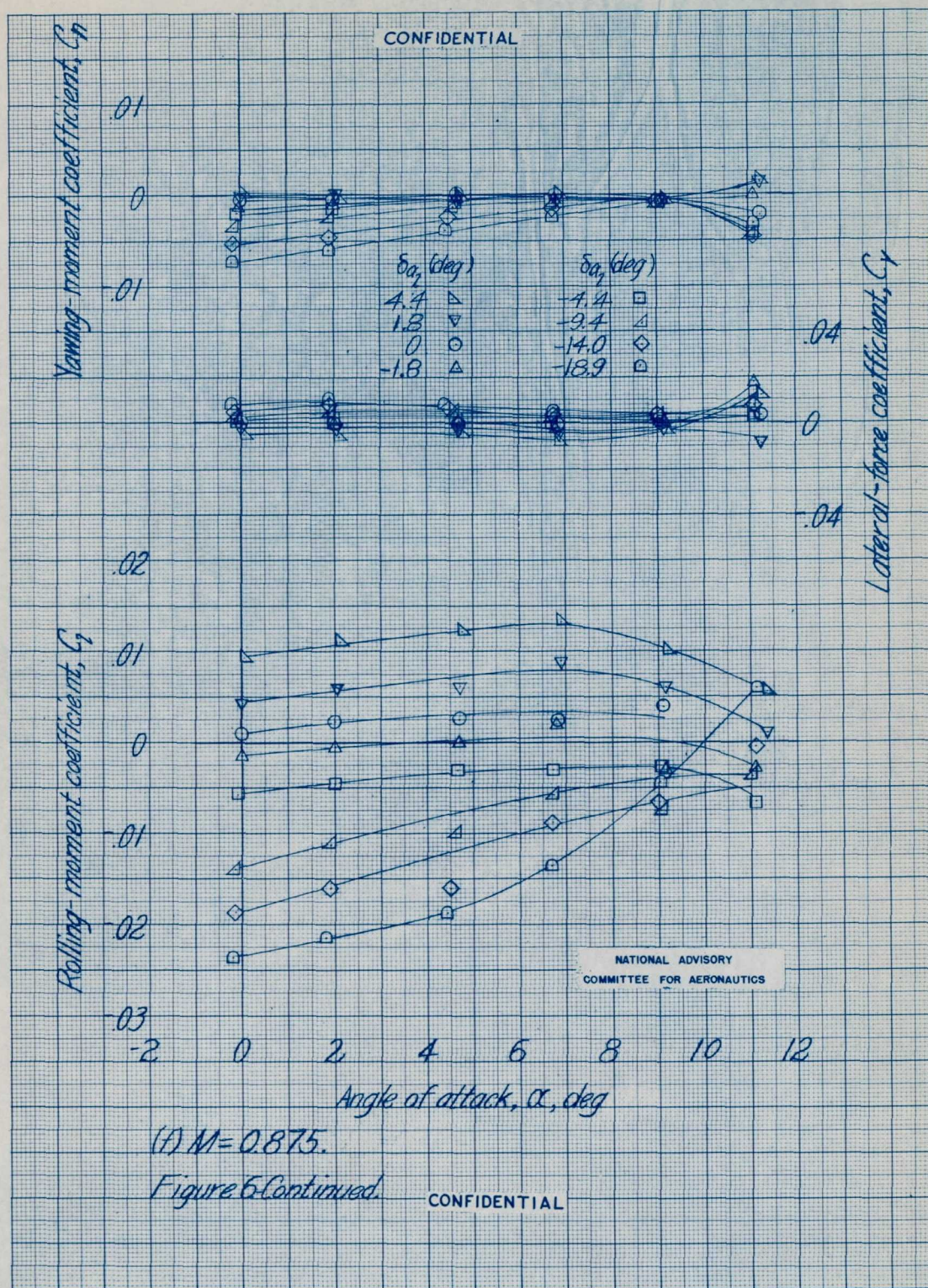
(b) $M = 0.60$.

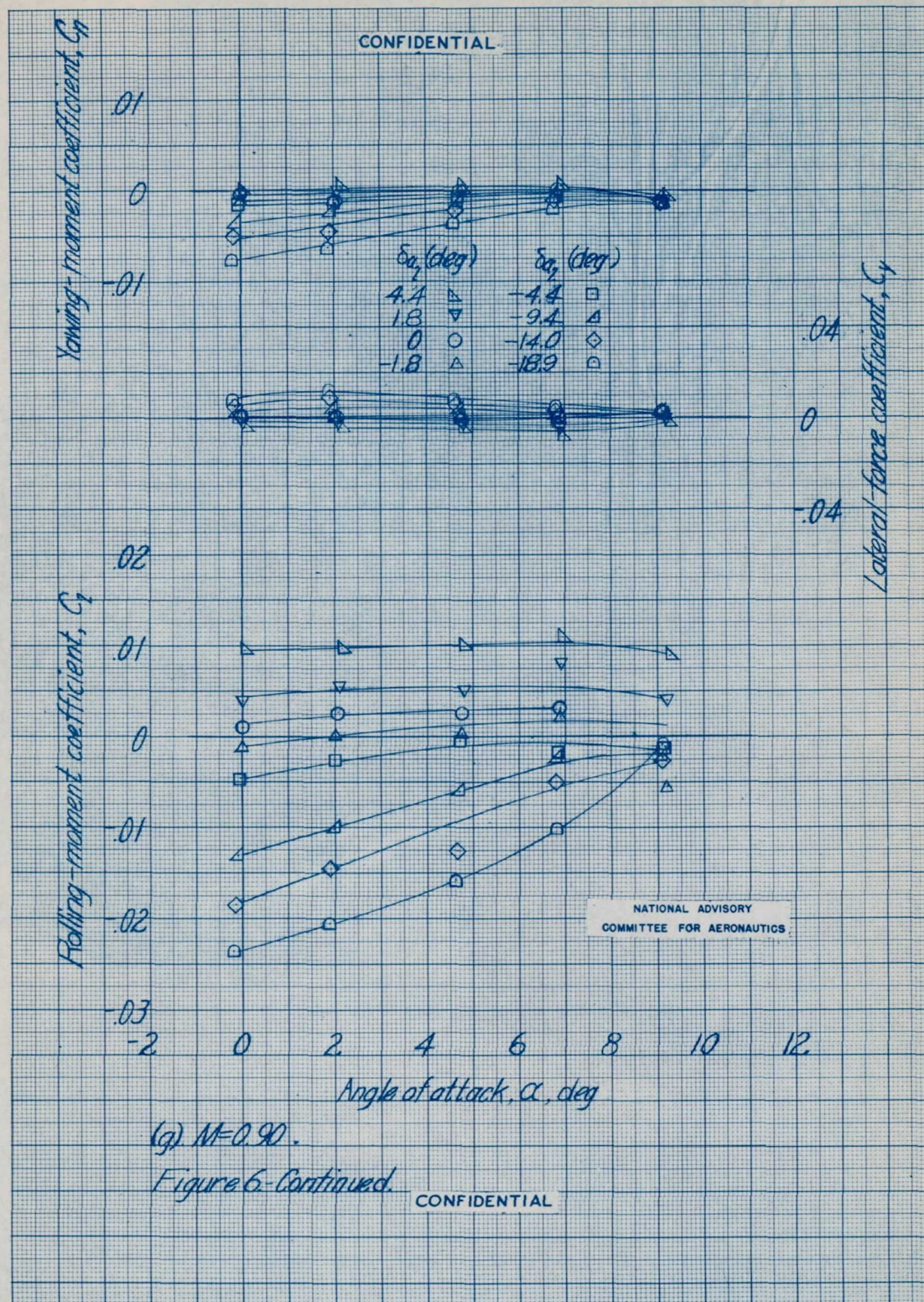
Figure 6.-Continued.

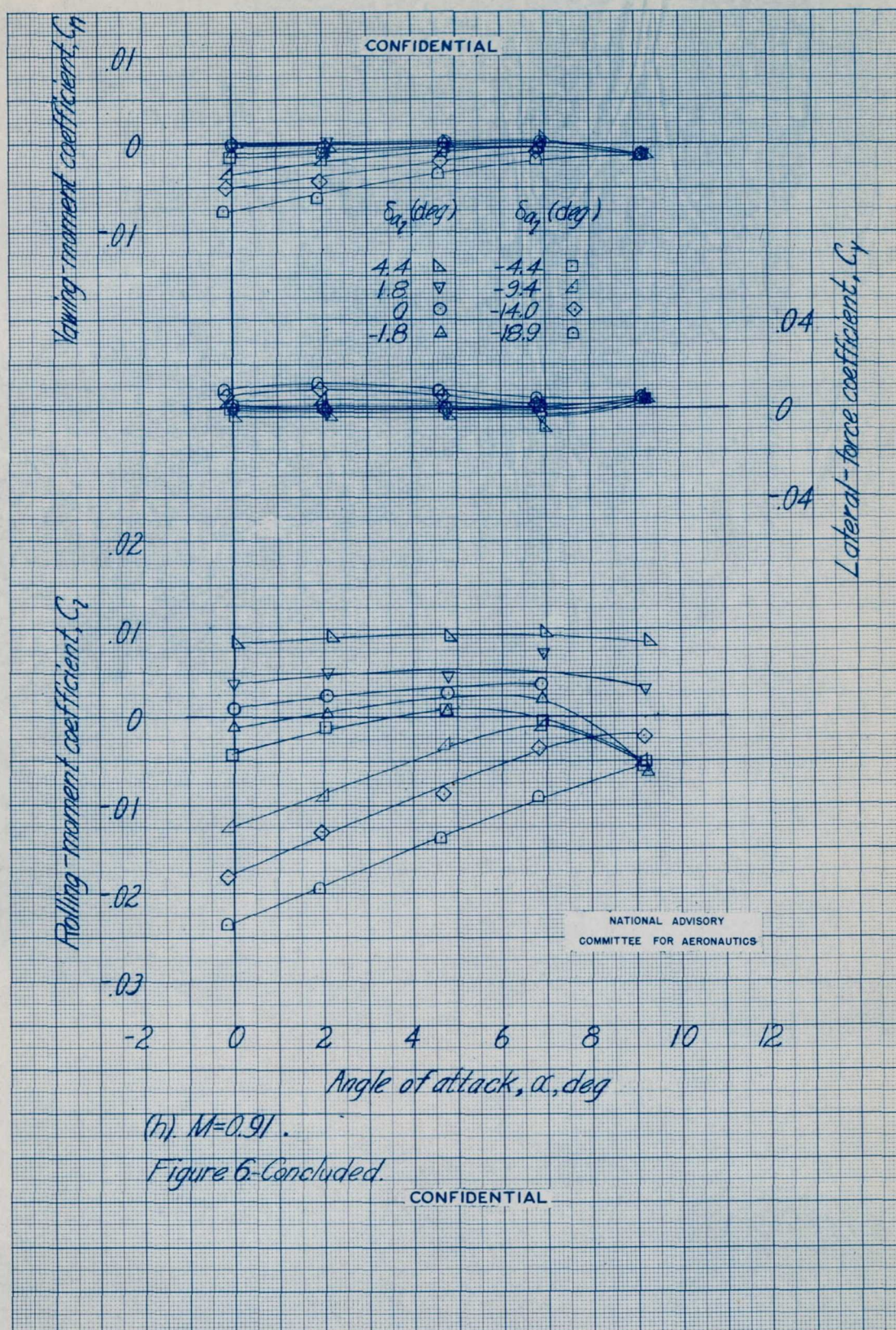


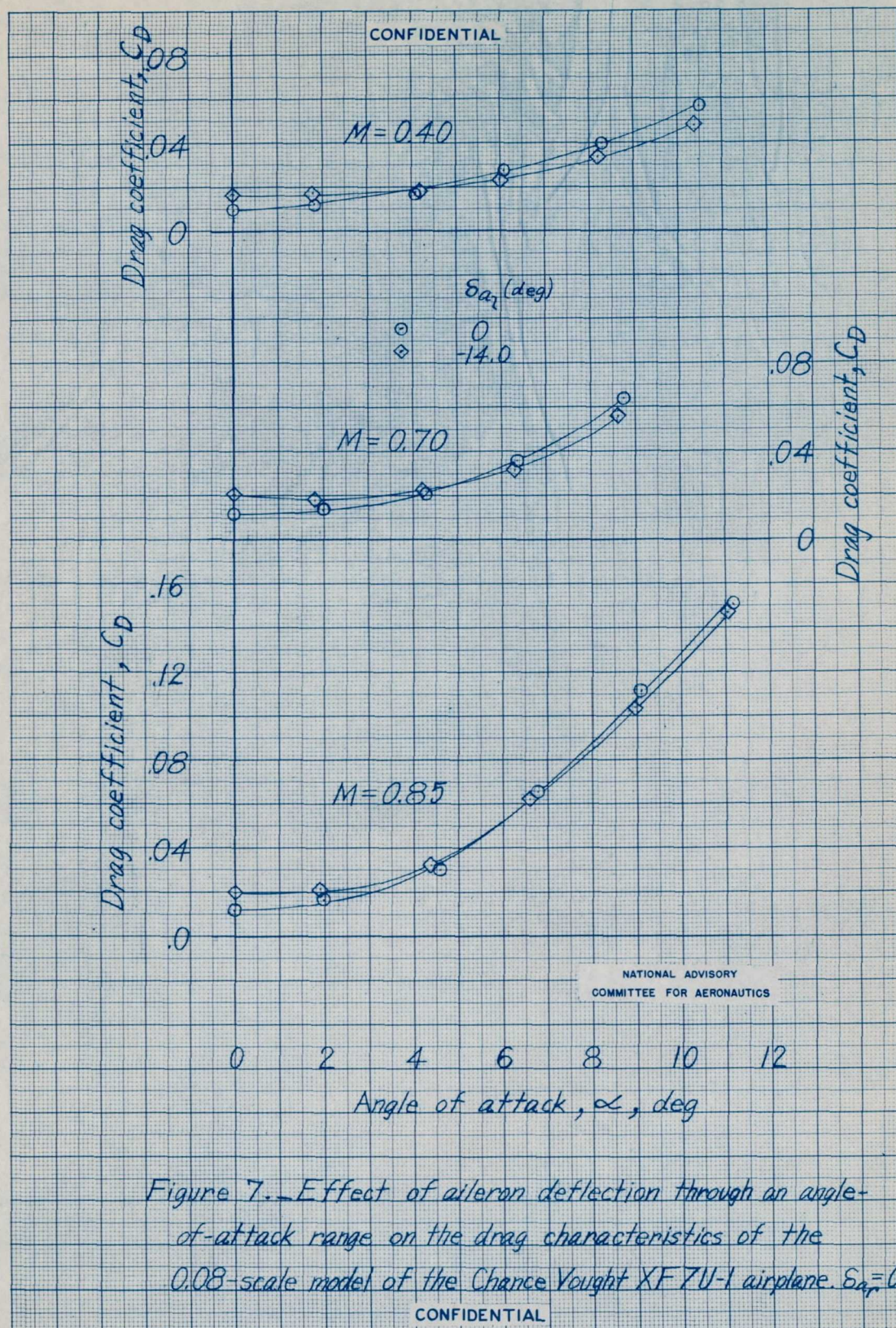












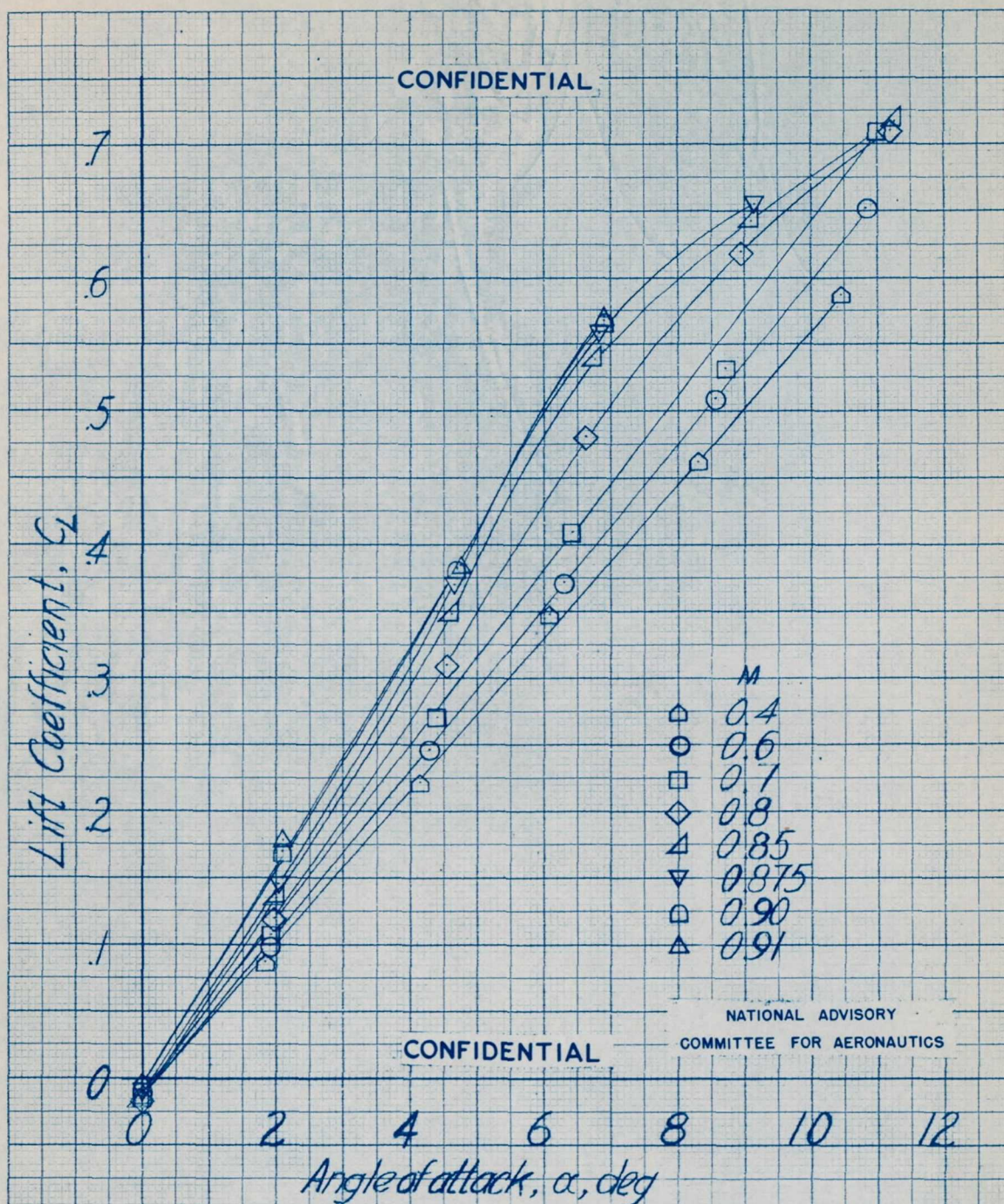
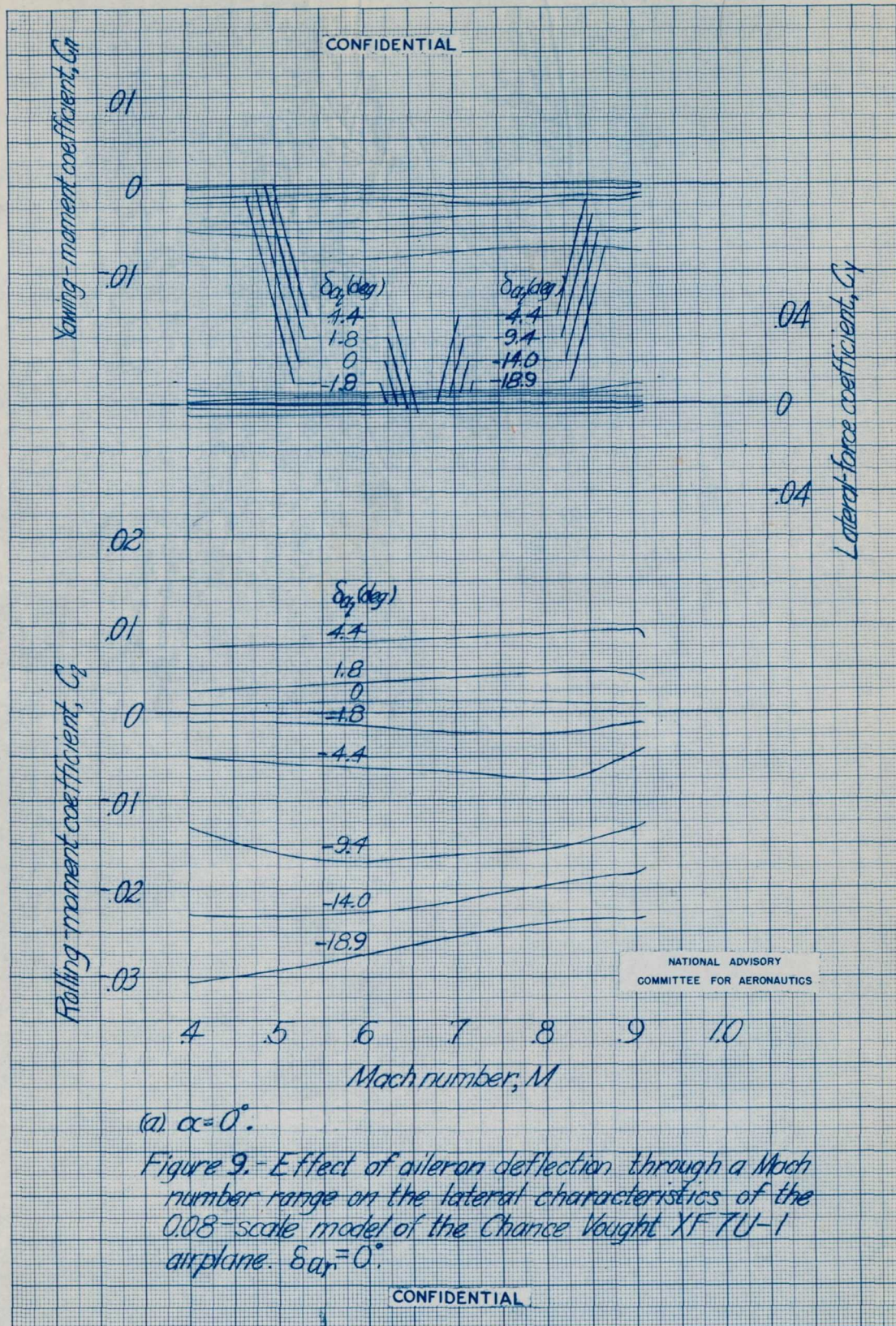
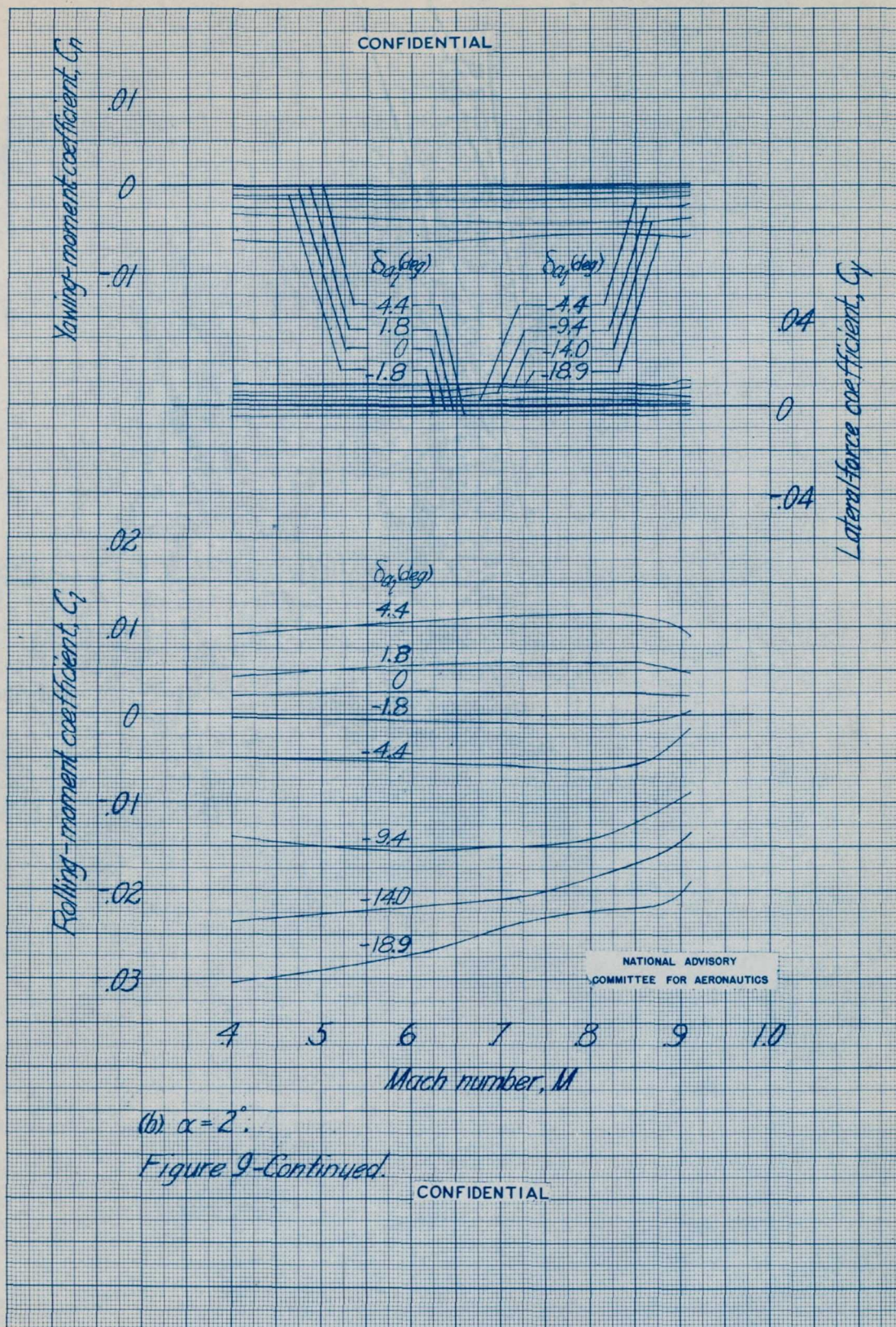
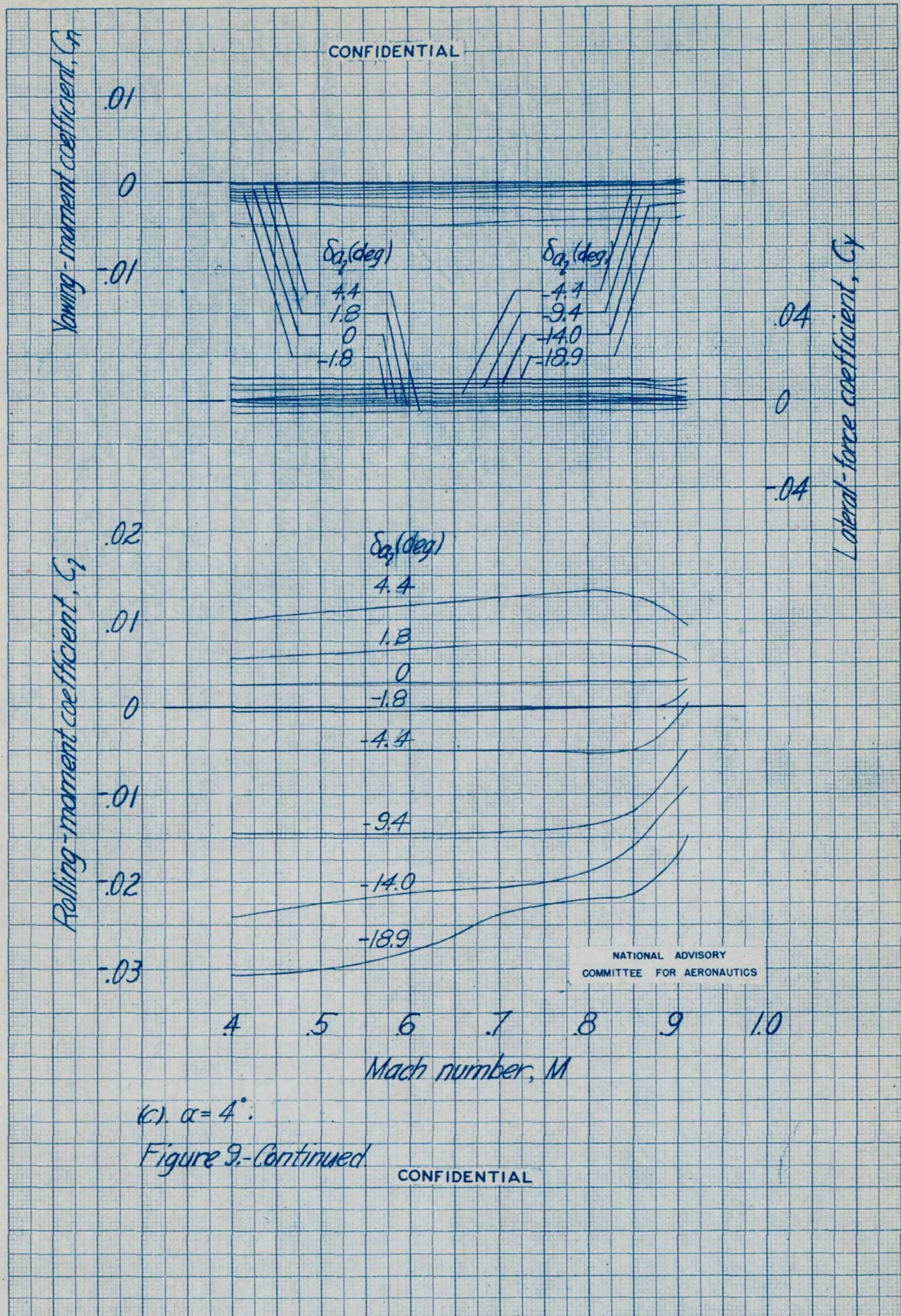
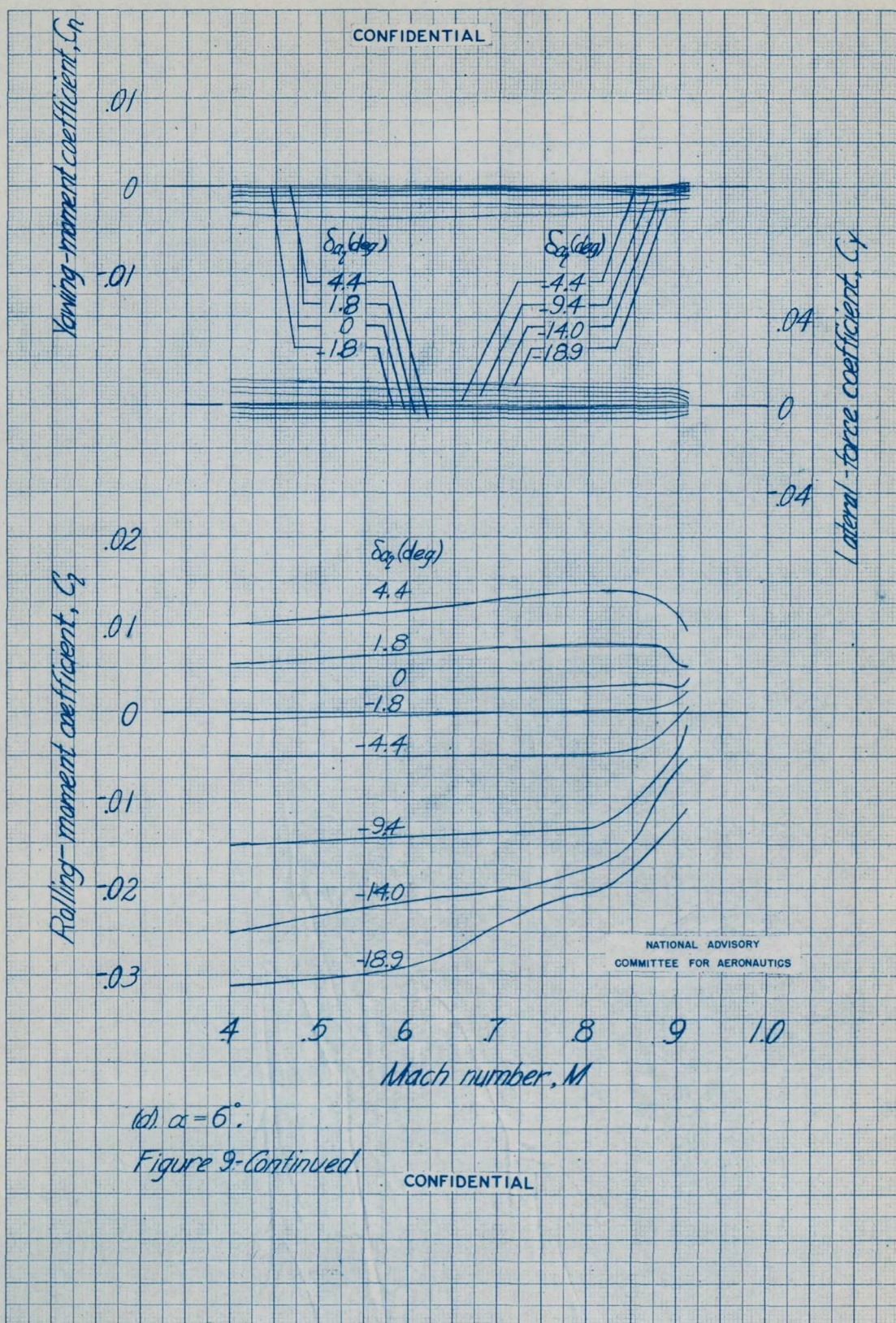


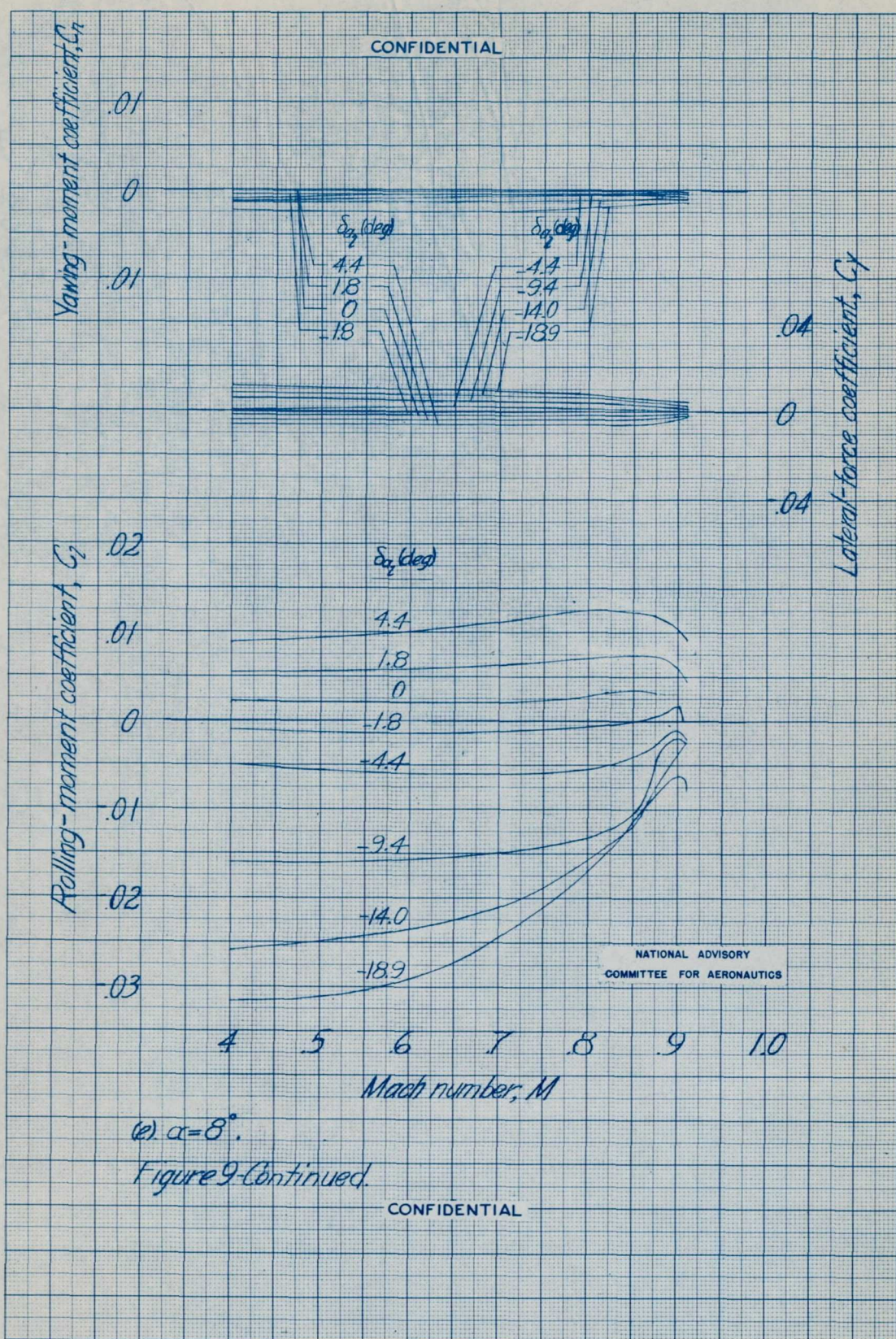
Figure 8.- Variation of lift coefficient with angle of attack at various Mach numbers of the 0.08-scale model of the Chance Vought XF7U-1 airplane, $\delta_{a_2} = \delta_{a_1} = 0$.

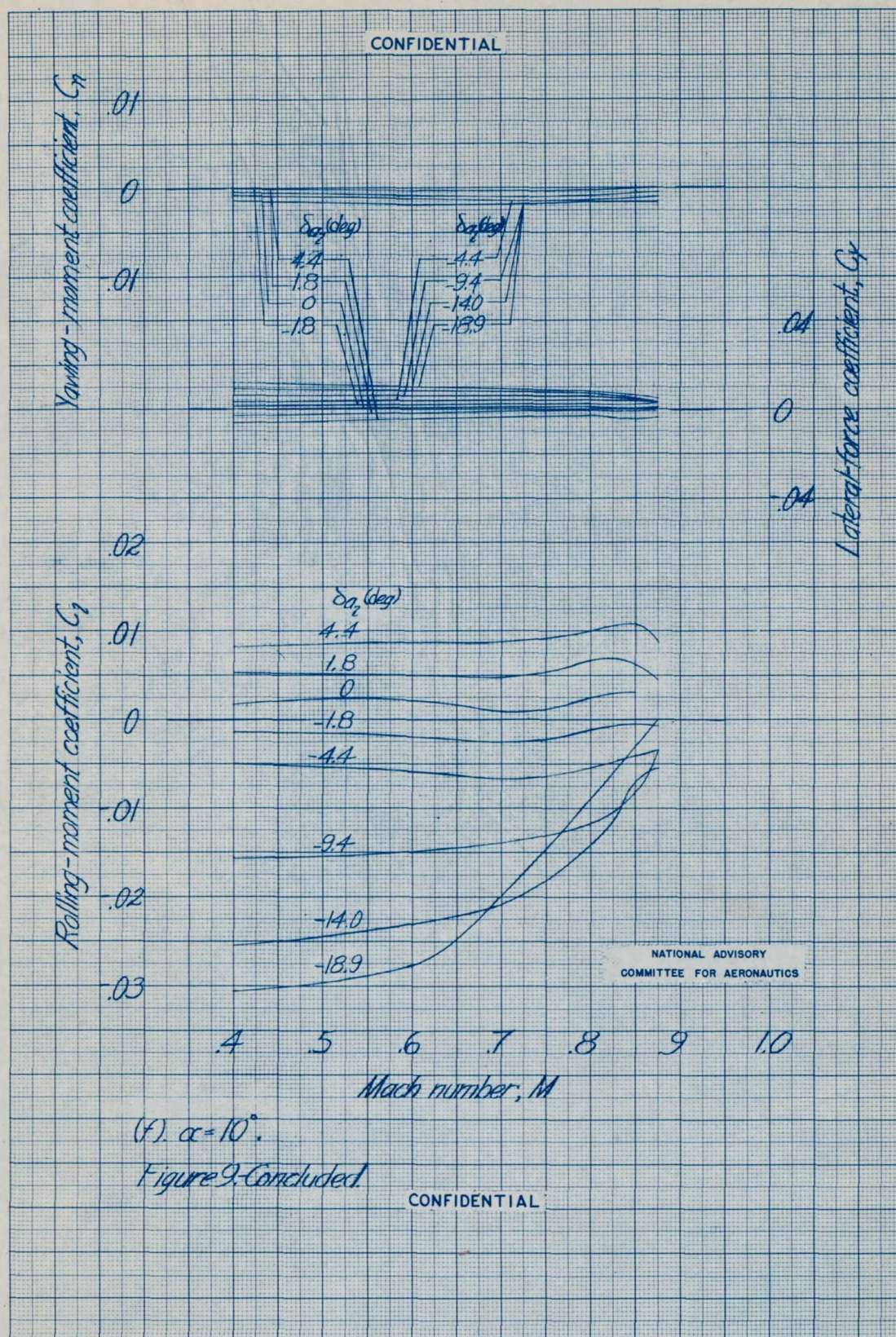












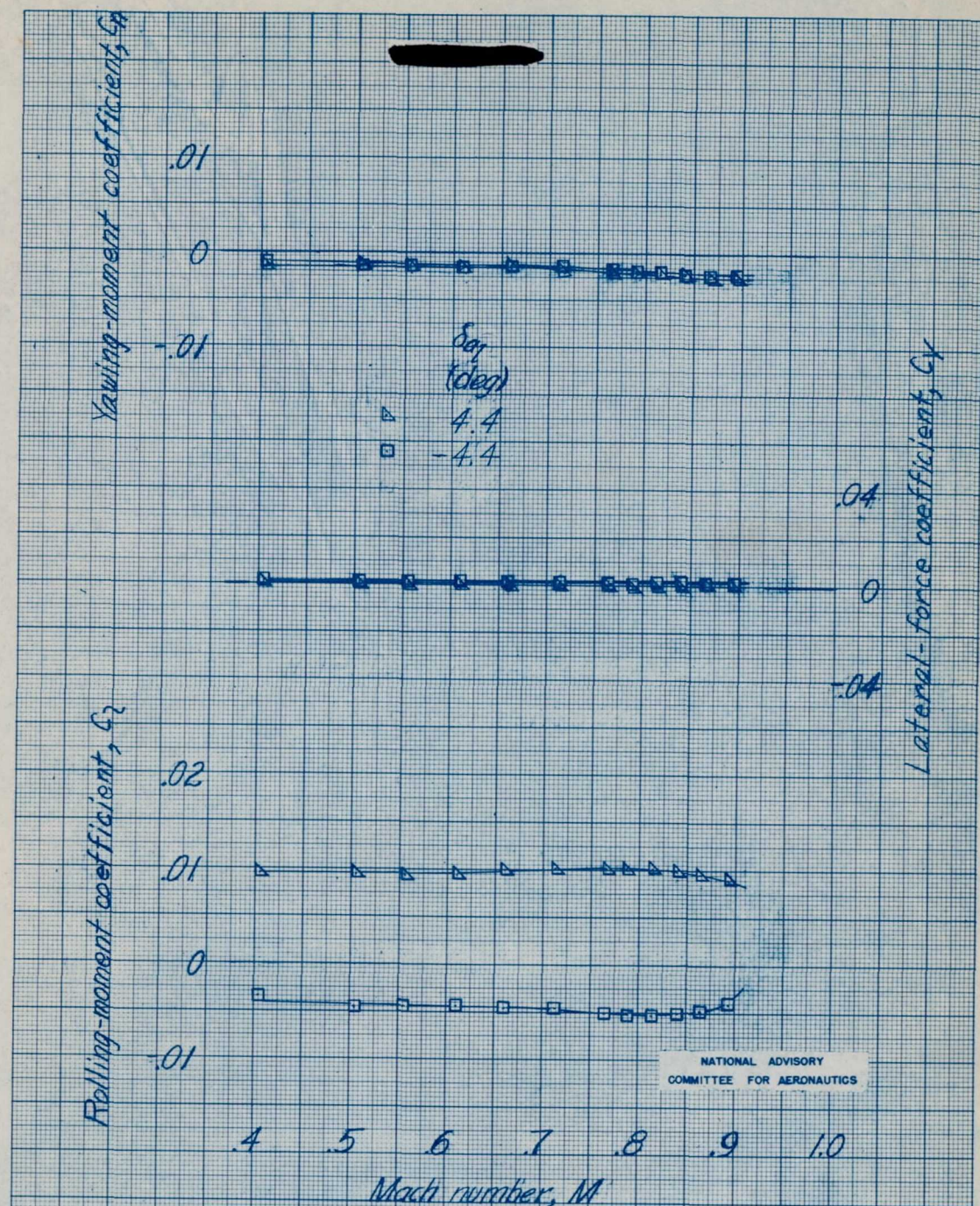


Figure 10. - Effect of aileron deflection through a Mach number range on the lateral characteristics of the 0.08-scale model of the Chance Vought XF7U-1 airplane. $\delta a_r = 0^\circ$, vertical tails off, $\alpha_{static} = 2^\circ$.